

UNCLASSIFIED

---

AD 296 796

*Reproduced  
by the*

ARMED SERVICES TECHNICAL INFORMATION AGENCY  
ARLINGTON HALL STATION  
ARLINGTON 12, VIRGINIA



---

UNCLASSIFIED

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

63-2-4

ASTIA

AS AD NO.

296796

296 796

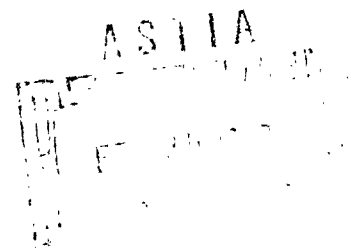
Technical Report

**R 235**



A STUDY OF THE EFFECTIVENESS OF  
FUEL-OIL ADDITIVES IN USE IN THE  
ELEVENTH NAVAL DISTRICT

27 November 1962



U. S. NAVAL CIVIL ENGINEERING LABORATORY  
Port Hueneme, California

**A STUDY OF THE EFFECTIVENESS OF FUEL-OIL ADDITIVES IN USE IN THE  
ELEVENTH NAVAL DISTRICT**

**Y-F015-99-014**

**Type C    Final Report**

**by**

**J. S. Williams**

**ABSTRACT**

A survey was conducted at a number of heat-plant installations at bases in the Eleventh Naval District to determine the need for the use of additives to prevent sludge in No. 6 fuel-oil storage tanks.

The fact that no sludging problems could be found at bases not using an additive indicated that a need did not exist. Several of the facilities reported that additives decreased the formation of soot by improving the combustion. A test was made to check the validity of these claims. An additional test without additive showed that changes in operating schedules would also reduce soot accumulation. It was concluded that no requirement exists for additives for sludge prevention. It was further concluded that combustion catalysts are beneficial for boilers operating under intermittent and cycling conditions, but that no substantial benefit results from the use of catalysts when boilers are operated continuously.

Qualified requesters may obtain copies of this report from ASTIA.  
The Laboratory invites comment on this report, particularly on the  
results obtained by those who have applied the information.

## BACKGROUND

At the request of the Power Generation Branch of the Bureau of Yards and Docks, a comprehensive survey of government and private activities was made by the Office of Research to determine the effectiveness of commercial additives, sludge solvents, and emulsifiers. Replies to the survey inquiries were inconsistent and opinionated and, therefore, inconclusive. It was found that some activities had sludge problems and others had none. Of those that had problems, some felt that additives were beneficial and others found that they were not effective. To resolve the contradictory findings of the Bureau's survey, the Laboratory was assigned the task in September 1954 of making a field survey of naval shore activities.

## NCEL INVESTIGATION

A number of facilities in the Eleventh Naval District were visited in December of 1954 at the following locations:

- Marine Corps Base, Camp Pendleton, California
- Naval Hospital, Camp Pendleton, California
- Naval Hospital, San Diego, California
- Naval Training Center, San Diego, California
- Naval Air Station, North Island, San Diego, California
- Marine Corps Supply Depot, Barstow, California
- Naval Ordnance Test Station, China Lake, California
- Construction Battalion Center, Port Hueneme, California
- U. S. Naval Station, San Diego, California
- Marine Corps Recruit Depot, San Diego, California
- Naval Air Missile Test Center, Point Mugu, California
- Naval Amphibious Base, Coronado, California

In most cases the initial contact was made with the Public Works Officer at each station. This was followed by discussions with the officers and civilians having direct responsibility for the boiler operation. Where available, log sheets were inspected. These were of little value since the figures did not provide the necessary information such as comparative data with and without additives.

The disturbing feature of the investigation was the complete lack of any factual data regarding sludging in fuel tanks. Reports of sludge problems turned out to be hearsay about conditions existing as long ago as five to ten years.

Among those using some form of fuel-oil additive, it was the general consensus that beneficial results were obtained on the fire side of the boiler. In many cases, however, the comparison was unreliable since other factors had also been changed. Operators using an additive were certain that it helped, which contrasted sharply with the opinion of others not using additives. This tended to decrease the value of any testimony. Also, no particular problems seemed to be generated at those stations not using additives.

During the period from 1954 to June 1962, only one report of a sludging problem was made to the Laboratory. The station reporting claimed that heavy sludge was present in two storage tanks. Plans were worked out by Station and Laboratory personnel to treat the sludge with a well-known additive. One of the steps in the treatment required pumping the tanks down to the sludge level. It was found that no sludge was present in either tank. No explanation was given for the erroneous report.

In the course of conducting the initial investigation, it was learned that the fuel supply at NAS, North Island, had just been changed from "Navy Special" to No. 6 grade. This oil was stored in a large tank near the boiler plant. It was decided to keep this tank under observation to determine whether sludging would occur. Periodic checks with NAS revealed that no trouble was encountered. In January 1962, a letter was sent to the Station requesting information. This letter and the reply are reproduced at the end of this report. Paragraph one of the NAS letter refers to inspection and cleaning of tanks. It is known that no cleaning of the large tank was done. The two service tanks were pumped out to repair the heater coils, but no evidence of sludge was found.

## USE OF ADDITIVES AS COMBUSTION CATALYSTS

An experiment was made on the use of fuel-oil additives for improving the combustion of heating boilers, to check the validity of glowing reports received from many boiler-plant supervisors.

The survey had shown that the boiler plant at the Amphibious Base, Coronado, did not use additives. In talking with the plant personnel, it was also learned that fire-side cleaning was necessary after every 1000 hours steaming. The need for water-side maintenance was negligible due to careful water treatment.

Approval was obtained from the local PWO and the District PWO to conduct a series of tests on one or more of the fire-tube boilers in the heating plant. It was agreed that if tests showed that carbon deposits in the tubes could be reduced sufficiently in one 1000-hour run, the steaming time would be extended to 1500 hours and eventually to 3000 hours. In essence, this is equivalent to one year of operation for a boiler that is alternated with two others.

A representative dual-purpose (antisludge and combustion catalyst) additive was used to treat the fuel oil in the 25,000-gallon storage tank. The chemical was added each time a truck load of fuel was delivered. In this manner, good mixing was obtained.

The ensuing tests were entirely qualitative. Lack of data on water consumption or steam production prevented comparison of untreated fuel control runs with treated fuel runs. Examination of the tubes and flues at the conclusion of the 1000-hour test showed a drastic reduction in carbon deposits. When operated for 1500 hours there was no additional build-up of carbon.

The final test consisted of an uninterrupted 2000-hour steaming run, a physical inspection by the district inspector, and a final 1000-hour steaming for a total of 3000 hours without cleaning. The 3000-hour period ended 21 February 1958. No increase in soot deposits was observed at this time.

The Amphibious Base submitted two letter reports dated 23 April and 20 May 1958. The 23 April letter reported some pitting of the fire brick in the fire tunnel and also deterioration of the outlet edge of the fire cone which surrounds the burner flame. This latter condition had not occurred previously according to boiler-plant personnel. One boiler was steamed continuously for an additional 1150 hours with no additive. The 20 May report stated that the amount of soot found in the tubes was only about two-thirds more than on runs with the additive, which would still be an insignificant amount.

## CONCLUSIONS

The lack of actual difficulty being experienced at the naval stations in the Eleventh Naval District indicates that no general requirement exists for an anti-sludging additive for No. 6 fuel oil storage

When fire-tube boilers are operated intermittently with cyclic loading, more soot accumulates in both tubes and flues than when the boiler is steamed continuously at a steady load. The tests conducted showed improvement could be obtained by

using a combustion catalyst for the condition of intermittent and uneven firing. The data indicate that about the same results can be obtained without additives by continuous steaming, even under varying load conditions.

It is evident that most of the sooting must occur at start-up when the boiler is cold and the flue gas temperature drops below the carbon ignition point before all the fuel is completely burned. The more times a boiler is placed on the line during a steaming cycle, the greater the soot deposit will be.



U. S. NAVAL CIVIL ENGINEERING  
LABORATORY  
PORT HUENEME, CALIFORNIA

In Reply Refer To:  
L62/JSW/l  
Serial 122  
24 Jan 1962

From: Commanding Officer and Director  
To: Commanding Officer, U. S. Naval Air Station, North Island,  
San Diego 35, California

Subj: Fuel Oil Additives; information on

1. In December 1954 the Laboratory conducted a survey on additives used as sludge dispersants in fuel oil, No. 6 grade in particular. During his visit to the Naval Air Station, the investigator learned that the boiler plant had changed to No. 6 oil about a year earlier. No additives were being used and no difficulty had been experienced with the heavier oil. The situation was unchanged in 1956 and in 1958. It was recognized that because of the large storage tank, sludging, if it did occur, might exist a long time before any adverse effects were observed.

2. It is requested that a brief history of sludging problems in the large tank, if any, be forwarded to the Laboratory. Information is also desired concerning the Station's use of any additive for either sludge control or improved combustion. A description of the method of addition would be helpful. This information will be used to complete a report to the Bureau of Yards and Docks concerning the value of sludge-control additives.

H. J. SIELAND  
By direction

Copy to:  
DPWO 11ND

U. S. NAVAL AIR STATION  
NORTH ISLAND  
SAN DIEGO 35, CALIFORNIA

In Reply Refer To  
CGR:orf  
80.5- 130  
6 Feb 1962

From: Commanding Officer, U. S. Naval Air Station, North Island,  
San Diego 35, California  
To: Commanding Officer and Director, U. S. Naval Civil Engineering  
Laboratory, Port Hueneme, California

Subj: Fuel Oil Additives; information on

Ref: (a) NAVCIVENGRLAB ltr L62/JSW/lr Serial 122 of 24 Jan 1962

1. Reference (a) requested information as to the use of fuel oil additives as sludge dispersants in fuel oil, No. 6 grade in particular. No additives have been used and no difficulty has been experienced. No inspection or cleaning of large storage tank or the two fuel oil service tanks has been conducted since September 1957.
2. Since March 1960 a metal conditioning compound has been used to clean fireside tubes and uptakes after each 2,000 steaming hours to improve boiler combustion. The tubes are blown clean with air and then sprayed with the compound. This remains on the tubes until the next steaming period with a minimum shut-down of seven days. This procedure effectively keeps the firesides and uptakes clean. Prior to using this compound, large carbon deposits on fireside tubes and heavy sooting in the uptakes occurred.
3. The produce is Metal Conditioning Compound, SPEC. MIL-M-15205, Type I, Light; viscosity 100-200 SSU, 100°F.; ninety-day maximum conditioning period; flash point 280°F; minimum, open cup. Supplier: Federal Stock Number KZ-8030-225-4448 as listed under Index No. 11203 of Military Industrial Supply Agency, FSC GP 80 Part I, Federal Supply Catalog C5-14 Dept. of Defense Section.
4. Approximately five gallons per boiler cleaning are used for a total of 150 gallons annually, at a cost of \$.50 per gallon.

J. H. LOFLAND, Jr.  
By direction

# **DISTRIBUTION LIST**

<b>No. of copies</b>	<b>SNDL Code</b>	
10		Chief, Bureau of Yards and Docks (Code 70)
1	23A	Naval Forces Commanders (Taiwan Only)
4	39B	Construction Battalions
10	39D	Mobile Construction Battalions
3	39E	Amphibious Construction Battalions
2	39F	Construction Battalion Base Units
1	A2A	Chief of Naval Research - Only
2	A3	Chief of Naval Operation (OP-07, OP-04)
5	A5	Bureaus
2	B3	Colleges
2	E4	Laboratory ONR (Washington, D. C. only)
1	E5	Research Office ONR (Pasadena only)
1	E16	Training Device Center
7	F9	Station - CNO (Boston; Key West; San Juan; Long Beach; San Diego; Treasure Island; and Rodman, C. Z. only)
6	F17	Communication Station (San Juan; San Francisco; Pearl Harbor; Adak, Alaska; and Guam only)
1	F41	Security Station
1	F42	Radio Station (Oso and Cheltenham only)
1	F48	Security Group Activities (Winter Harbor only)
8	H3	Hospital (Chelsea; St. Albans, Portsmouth, Va; Beaufort; Great Lakes; San Diego; Oakland; and Camp Pendleton only)
1	H6	Medical Center
2	J1	Administration Command and Unit - BuPers (Great Lakes and San Diego only)
1	J3	U. S. Fleet Anti-Air Warfare Training Center (Virginia Beach only)
2	J4	Amphibious Bases
1	J19	Receiving Station (Brooklyn only)
1	J34	Station - BuPers (Washington, D. C. only)
1	J37	Training Center (Bainbridge only)
1	J46	Personnel Center
1	J48	Construction Training Unit
1	J60	School Academy
1	J65	School CEC Officers
1	J84	School Postgraduate
1	J90	School Supply Corps

# Distribution List (Cont'd)

No. of copies	SNDL Code	
1	J95	School War College
1	J99	Communication Training Center
11	L1	Shipyards
4	L7	Laboratory - BuShips (New London; Panama City; Carderock; and Annapolis only)
5	L26	Naval Facilities - BuShips (Antigua; Turks Island; Barbados; San Salvador; and Eleuthera only)
1	L30	Submarine Base (Groton, Conn. only)
2	L32	Naval Support Activities (London & Naples only)
2	L42	Fleet Activities - BuShips
4	M27	Supply Center
6	M28	Supply Depot (Except Guantanamo Bay; Subic Bay; and Yokosuka)
2	M61	Aviation Supply Office
15	N1	BuDocks Director, Overseas Division
28	N2	Public Works Offices
7	N5	Construction Battalion Center
5	N6	Construction Officer-in-Charge
1	N7	Construction Resident-Officer-in-Charge
12	N9	Public Works Center
1	N14	Housing Activity
2	R9	Recruit Depots
2	R10	Supply Installations (Albany and Barstow only)
1	R20	Marine Corps Schools, Quantico
3	R64	Marine Corps Base
1	R66	Marine Corps Camp Detachment (Tongen only)
6	W1A1	Air Station
35	W1A2	Air Station
8	W1B	Air Station Auxiliary
4	W1C	Air Facility (Phoenix; Monterey; Oppama; Naha; and Naples only)
4	W1E	Marine Corps Air Station (Except Quantico)
1	W1F	Marine Corps Auxiliary Air Station
8	W1H	Station - BuWeps (Except Rota)
1		Deputy Chief of Staff, Research and Development, Headquarters, U. S. Marine Corps, Washington, D. C.
1		President, Marine Corps Equipment Board, Marine Corps School, Quantico, Va.
2		Library of Congress, Washington, D. C.
10		Director, Office of Technical Services, Department of Commerce, Washington, D. C.

# Distribution List (Cont'd)

## No. of copies

- 1 Chief of Staff, U. S. Army, Chief of Research and Development, Department of the Army, Washington, D. C.
- 1 Office of the Chief of Engineers, Assistant Chief of Engineering for Civil Works, Department of the Army, Washington, D. C.
- 1 Chief of Engineers, Department of the Army, Attn: Engineering R & D Division, Washington, D. C.
- 1 Chief of Engineers, Department of the Army, Attn: ENG CW-OE, Washington, D. C.
- 1 Director, U. S. Army Engineer Research and Development Laboratories, Attn: Information Resources Branch, Fort Belvoir, Va.
- 1 Headquarters, Wright Air Development Division, (WWAD-Library), Wright-Patterson Air Force Base, Ohio
- 3 Headquarters, U. S. Air Force, Directorate of Civil Engineering, Attn: AFOCE-ES, Washington, D. C.
- 1 Commanding Officer, U. S. Naval Construction Battalion Center, Port Hueneme, Calif., Attn: Materiel Dept., Code 140
- 1 Deputy Chief of Staff, Development, Director of Research and Development, Department of the Air Force, Washington, D. C.
- 1 Director, National Bureau of Standards, Department of Commerce, Connecticut Avenue, Washington, D. C.
- 2 Office of the Director, U. S. Coast and Geodetic Survey, Washington, D. C.
- 10 Armed Services Technical Information Agency, Arlington Hall Station, Arlington, Va.
- 2 Director of Defense Research and Engineering, Department of Defense, Washington, D. C.
- 2 Director, Division of Plans and Policies, Headquarters, U. S. Marine Corps, Washington, D. C.
- 2 Director, Bureau of Reclamation, Washington, D. C.
- 1 Commanding Officer, U. S. Navy Yards and Docks Supply Office, U. S. Naval Construction Battalion Center, Port Hueneme, Calif.
- 1 Facilities Officer (Code 108), Office of Naval Research, Washington 25, D. C.
- 1 Federal Aviation Agency, Office of Management Services, Administrative Services Division, Washington 25, D. C. Attn: Library Branch
- 1 Officer in Charge, U. S. Naval Supply Research and Development Facility, Naval Supply Center, Bayonne, N. J.
- 1 Commander, U. S. Naval Shipyard, Attn: Materials and Chemical Laboratory, Boston
- 1 Commander, U. S. Naval Shipyard, Attn: Material Laboratory, Brooklyn, N. Y.
- 1 U. S. Naval Research Laboratory, Chemistry Division, Washington, D. C.

U. S. Naval Civil Engineering Laboratory  
Technical Report R-235  
A STUDY OF THE EFFECTIVENESS OF FUEL-OIL  
ADDITIVES IN USE IN THE ELEVENTH NAVAL  
DISTRICT, by J. S. Williams  
9 p. illus 27 Nov 62 UNCLASSIFIED

A survey was conducted at a number of heat-  
plant installations at bases in the Eleventh Naval  
District to determine the need for the use of addi-  
tives to prevent sludge in No. 6 fuel-oil storage  
tanks.

1. Fuel-Oil Additives  
I. Williams, J. S.  
II. Y-F015-99-014

U. S. Naval Civil Engineering Laboratory  
Technical Report R-235  
A STUDY OF THE EFFECTIVENESS OF FUEL-OIL  
ADDITIVES IN USE IN THE ELEVENTH NAVAL  
DISTRICT, by J. S. Williams  
9 p. illus 27 Nov 62 UNCLASSIFIED

A survey was conducted at a number of heat-  
plant installations at bases in the Eleventh Naval  
District to determine the need for the use of addi-  
tives to prevent sludge in No. 6 fuel-oil storage  
tanks.

1. Fuel-Oil Additives  
I. Williams, J. S.  
II. Y-F015-99-014

U. S. Naval Civil Engineering Laboratory  
Technical Report R-235  
A STUDY OF THE EFFECTIVENESS OF FUEL-OIL  
ADDITIVES IN USE IN THE ELEVENTH NAVAL  
DISTRICT, by J. S. Williams  
9 p. illus 27 Nov 62 UNCLASSIFIED

A survey was conducted at a number of heat-  
plant installations at bases in the Eleventh Naval  
District to determine the need for the use of addi-  
tives to prevent sludge in No. 6 fuel-oil storage  
tanks.

1. Fuel-Oil Additives  
I. Williams, J. S.  
II. Y-F015-99-014

U. S. Naval Civil Engineering Laboratory  
Technical Report R-235  
A STUDY OF THE EFFECTIVENESS OF FUEL-OIL  
ADDITIVES IN USE IN THE ELEVENTH NAVAL  
DISTRICT, by J. S. Williams  
9 p. illus 27 Nov 62 UNCLASSIFIED

A survey was conducted at a number of heat-  
plant installations at bases in the Eleventh Naval  
District to determine the need for the use of addi-  
tives to prevent sludge in No. 6 fuel-oil storage  
tanks.

1. Fuel-Oil Additives  
I. Williams, J. S.  
II. Y-F015-99-014